

EXPERIMENTS  
AND  
OBSERVATIONS  
ON THE  
CRESCENT WATER  
AT  
*Harrogate.*

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AND OF THE  
AMERICAN PHILOSOPHICAL SOCIETY AT  
PHILADELPHIA, &c. &c. &c.

A MAN ON WHOM MY PRAISES CAN  
CONFER NO HONOR.

ON ACCOUNT OF NUMEROUS  
OBLIGATIONS,

AND AS A SMALL TOKEN OF ESTEEM  
FOR A CHARACTER  
SO DESERVEDLY RESPECTED,

*THIS ESSAY IS INSCRIBED,*

BY

*The Author.*

*Harrogate,*  
*May 1<sup>st</sup>, 1791. }*

Dr. Gregory

with respectful compliments

from

his obedient servant

The Author.

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*Experiments and Observations, &c.*

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THE medicinal springs at Harrogate in Yorkshire, have long been in high repute, and much resorted to ; and, as Dr. Short observes,\* this place may justly challenge Britain, and perhaps all Europe, for the great number and variety of its mineral waters. Nothing can speak more highly in praise of those waters, than the great numbers of patients whose diseases have long resisted the power of medicine, but which have been cured here. In places where there is only one  
B mineral

\* History of Mineral Waters, page 237.

mineral water, that water may be highly proper in certain complaints; but it is perfectly obvious, even to those not much conversant in medicine, that, since diseases are so very different, and often directly opposite in their nature, it is impossible for one remedy to cure all; nay, it is equally evident, that if a remedy is found to be of service in any particular disease, it must be prejudicial in complaints of an opposite nature.

The number and variety of mineral waters at Harrogate, however, is such, as to afford relief in a great variety of diseases. Those commonly called the *sulphur wells*, are perhaps more generally useful than any other at this place; yet they ought not to be used indiscriminately; and there are many valetudinarians to whom a free use of the sulphur water is hurtful: I mean those whose habits are relaxed, and systems weakened, particularly where the powers of digestion are much impaired. Though a small quantity



tity of the sulphur water, may in these cases produce no bad effects, yet a free and liberal use of it, by increasing the debility already present, is very prejudicial. Such patients generally find more relief from a continued use of the chalybeate waters for a considerable length of time.

On the contrary, in diseases of an inflammatory nature, where a plethoric or too vigorous a state of the system exists, the chalybeates by acting as tonics, and consequently increasing that state of the body on which the disease depends, must be hurtful: here we may hope for the best effects from a judicious use of the sulphur water, and experience shows us that this hope is not ill grounded: for this water, by its cooling, purgative quality, has a tendency to diminish the inflammatory, or plethoric state of the body on which the disease depends.

I shall say nothing here, of those cutaneous eruptions which so often yield to  
a

a judicious use of the sulphur water. externally and internally applied, after they have baffled the efforts of medicine ; as I intend soon to lay before the public. a general treatise on the Harrogate waters, in which I shall be much more particular than is possible in this short essay.

It has often been wished by practitioners, that we were possessed of a mineral water, of a middle nature ; that is, one which was impregnated with iron, and yet contained a small quantity of purgative salt. Such a water might naturally be expected to produce good effects in dyspeptic complaints, or diseases of indigestion, where, at the same time that iron produces good effects as a tonic, it is necessary to keep the bowels open, or at least to prevent costiveness.

Of this nature is the water lately discovered in the gardens belonging to the Crescent, at Low Harrogate, and which, from its situation, has obtained the name of *CRESCENT WATER*. For though it may  
be



be imagined that the same effects might be produced by the alternate use of the simple chalybeate, and sulphur waters; yet it is highly probable that these different waters, mixed and combined in different proportions, by the chemistry of nature, may be better calculated to answer the purpose. To this conjecture we are led by the following curious fact, of the truth of which I have frequently assured myself, but which, I confess, I cannot explain in a satisfactory manner. When the simple chalybeate waters at High-Harrogate, are mixed with the sulphur water at Low-Harrogate, a decomposition soon takes place: the mixture assumes a blackish tinge; the iron is precipitated, and perhaps some other change is produced. The same effect follows from a mixture of the Crescent with the sulphur water. But though the Crescent contains all the principles of the sulphur water, viz. the salt and sulphureous gas, together with the principles of the chalybeates at High-Harrogate, yet it holds them all perfectly in solution.

It

It is, from hence, very probable, that if the sulphur and chalybeate waters are used together, or as they generally are, the sulphur water in the morning and the chalybeate soon after, they will decompose each other in the body; the iron will be precipitated; and in that form, the small quantity which was dissolved in a glass of the water will produce no sensible effect, for a very large quantity of the calx of iron may be taken without inconvenience; though the iron which is minutely dissolved in the water, notwithstanding its small quantity, may, and evidently does produce good effects as a tonic. In cases therefore, where good effects are to be expected from the union of chalybeate, and saline, as well as sulphureous principles, it is evident that a water which holds all these in solution, must be a desirable acquisition to Harrogate. Of this nature, the Crescent water will from the following analysis appear to be.

It

It is remarkable that the greatest and most useful discoveries have seldom been the result of philosophical investigation, but merely of chance ; for we have frequent instances of ignorant people, stumbling as it were, upon discoveries, which the philosopher has in vain attempted. This has been the case with many of the mineral waters, as well as several valuable medicines ; chance having discovered virtues in them, which the philosopher never dreamed of. This does not now, however, apply so accurately to mineral waters ; for, from the present improved state of chemistry, we are able to ascertain, with a great deal of nicety, the principles contained in them ; and from analogy, we can, in some measure, foretell their medicinal effects to be the same with other waters of the same nature.

The discovery of the Crescent water, was indeed owing to chance ; and soon after it was discovered, some chemical experiments were made to ascertain its nature,  
but

but I have never seen any attempt to analyze it accurately : this induced me to make the following experiments, which are submitted with diffidence to the inspection of the public. Every one who is acquainted with chemistry, must be sensible of the difficulty of the undertaking, the analysis of mineral waters, being, with great reason, looked upon as the most difficult part of chemistry : but I have undertaken the task with the greater confidence from the reflection that those who are best acquainted with the subject, will be the most ready to pardon any error or inaccuracy I may have committed in the following pages.

The Crescent water was discovered in the year 1783, by the proprietor. He had occasion to dig for fresh water, in a field, since converted into a garden ; but, contrary to his expectations, the water which he met with was so far from being pure, that it resembled that at the sulphur wells both in taste and smell. It was not  
however,



taken any notice of, but the well was filled up again a few weeks after it was opened. It happened however, that a person, who had used the other waters at Harrogate, without success, had been induced to try the Crescent, while it was open, without the knowledge of the proprietor, and received much benefit from it. The next year he returned to Harrogate, and inquired for the well ; upon being told that it was filled up, he prevailed upon the proprietor to open it again : in a little time a pump was put down, and since then it has been gradually advancing in reputation. The stone cistern or trough into which the water falls from the pump, is covered with a brown crust, evidently occasioned by the deposition of the iron and calcareous earth which this water contains.

I shall first give the general characters, and physical properties of the Crescent water, and then proceed to the experiments, which were made in the summer of 1790.

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The



The Crescent water when first taken from the pump, and poured from one glass into another, sparkles considerably, and emits numerous bubbles of air, which attach themselves to the inner surface of the glass.

It is not perfectly transparent, but more or less turbid at different times ; in general it has a whitish cloudy appearance.

The taste is saline, and rather vapid, imparting a certain smoothness to the palate ;\* it is much more pleasant than the sulphur water : a chalybeate taste is also very perceptible.

It has an evident sulphureous smell, or hepatic odour, though not near so strong as that emitted by the sulphur water.

By

\* This water seems much more strongly impregnated with fixed air in winter than in summer : I have found the taste quite acidulous, and very brisk, several times this last winter.

By means of a very good hydrometer, the specific gravity of this water was found to be to that of distilled water as 1020 to 1000, the temperature of both being 60 degrees.

On the 19th of August, 1790, I compared the temperature of the Crescent water with that of the atmosphere, and several other springs, and found the result to be as follows :

*Of Farenheit.*

Temperature of the Crescent Water,.....	52°
———— the pump in the yard.....	55°
———— the drinking sulphur well.....	54°
———— the well next the drinking well...	57°
———— the lowest sulphur well.....	56°
———— St. Magnus's well.....	51°
———— the atmosphere .....	60°

Hence, it appears, that the Crescent water is colder than any of the other mineral waters at Low-Harrogate, and nearly as cold as that spring commonly called, (though perhaps improperly) St. Mungo's  
or

or St. Magnus's Well,\* which is very pure water, and an excellent cold bath; though from what caprice I cannot tell, it has of late, been very much neglected.

### EXPERIMENT I.

On mixing a few drops of *tincture of galls* with the Crescent water, it soon assumes a fine purple tinge, which, by standing, grows darker, inclining to a black or dusky green. If the water on which this experiment is made, is exposed to the air, it entirely loses its dark colour; a variegated pellicle is seen on the surface, and in a few days, a brown precipitate falls to the bottom of the glass.

### EXPERIMENT II.

On mixing a few drops of the *Prussian alkali* with a glass of the Crescent water, a beautiful dark green was instantly produced;

\* The cold bath at Copgrove is most probably the well formerly dedicated to St. Mungo or Mongah. Vide Hargrove's History of Knarelsbro', p. 139.

duced ; and when the mixture had stood about half an hour, a fine blue precipitate fell to the bottom.

Both these experiments were repeated with water which had been exposed for twenty four hours to the air, in a glass, and also with water which had been slightly boiled ; but neither tincture of galls, nor Prussian alkali produced any change upon it in this state.

From these experiments, it is evident that the Crescent water is a chalybeate, or contains iron. Both the tincture of galls and Prussian alkali are very delicate tests for discovering the presence of this metal, particularly the latter, which discovers the most minute portion of iron imaginable. From the experiments with the water which had been exposed to the air, and that which had been boiled, it appears that the iron is held in solution by a very volatile principle, and which is easily dissipated. This is also evident  
from



from the purple colour produced by the tincture of galls : for if the iron is held in solution by the vitriolic or marine acid, the colour produced by tincture of galls, is always a blue, inclining to black.

### EXPERIMENT III.

A piece of paper, on which characters were written with a pen dipped in a solution of *saccharum saturni*, being placed over a glass, nearly filled with the water just drawn from the pump, the characters in about five minutes, became visible, and of a brown colour, but not near so dark as when such a paper is held over the sulphur water.

From this experiment, it is evident, that this water is impregnated with hepatic, or sulphureous air, though not in the same quantity as the sulphur water.

### EXPERIMENT IV.

When paper tinged by saturated tincture of *turnsole*, was dipped into a glass of  
this



this water taken fresh from the pump, its colour was evidently changed from purple to red; but no such change was produced when such a paper was dipped into water which had been exposed for six hours to the air in an open glass.

From this experiment, we may conclude, that this water is impregnated with an acid, since acids change the colour of paper tinged by tincture of turnsole to a red. From the experiment with water which had been exposed to the air, it is evident that the acid with which it is impregnated, is of a volatile nature, and escapes upon exposure to the air.

#### EXPERIMENT V.

When *salited terra ponderosa* is dropped into the water, white clouds are soon discovered; and after the mixture has stood some time, a small quantity of white sediment falls to the bottom of the glass.

This

This experiment shows that the Crescent water contains vitriolic acid. For the salited terra ponderosa discovers the smallest portion of that acid, with whatever substance it is combined; because the vitriolic acid has a greater attraction for the terra ponderosa than for any other substance, except phlogiston; and separates it from all the other acids, forming with it a *spatium ponderosum*, which is scarcely at all soluble in water.

#### EXPERIMENT VI.

A few drops of an aqueous solution of acid of sugar being mixed with a glass of the Crescent water, the mixture became turbid, and a white precipitate fell to the bottom of the glass.

This experiment shows that the Crescent water contains lime or calcareous earth; for the acid of sugar instantly discovers the most minute particle of lime, with whatever acid it is united. This  
acid

acid attracts lime with such force that it expells even the vitriolic acid itself, and all other acids hitherto known; and forms with it a salt very difficult of solution, which therefore falls to the bottom in the form of a white powder.\*

#### EXPERIMENT VII.

A little of the solution of silver in the nitrous acid, being dropped into a glass of the Crescent water, just taken from the pump, the mixture immediately became turbid, and a white sediment fell to the bottom.

#### EXPERIMENT VIII.

Lime water being mixed with the Crescent water, renders it turbid, and a precipitate in a little time falls to the bottom.

D

EX-

\* Bergman's Essays, Vol. I. p. 239.—also Essay on the acid of sugar.

## EXPERIMENT IX.

When the Crescent water was boiled with an equal quantity of new milk, it did not curdle it.

## EXPERIMENT X.

The Crescent water will not dissolve soap, but curdles it.

I next endeavoured to ascertain the nature of the permanent vapours contained in this water. But as I had found, from repeated trials, all the methods for collecting these volatile principles, recommended by authors, very inconvenient; I was in hopes that I could improve upon them; and after several attempts, I think I have hit upon a method of obtaining, and securing the volatile contents of waters, with ease, and sufficient accuracy. I took the hint from the perusal of a complex machine, described by M. Bergman, but which, I have found from experience, will not answer the

the purpose. The first attempt I made of this kind, I have related in a treatise which I published last year;\* but this was by no means so convenient as I could wish. I afterwards made use of the simple vessel delineated on the annexed plate, which I found by much the most convenient of any which I have seen, and which I shall here take the liberty to describe, as it may be useful to others who are engaged in similar pursuits.

The vessel E A C B D F is made of tin, and is of one entire piece; the part A C B D is cylindrical, and perfectly closed both at the bottom and top, excepting where the tube G, about two inches in length, is inserted. The cylindrical part holds exactly half a gallon, wine measure. To the top of this cylindrical part is soldered the shelving part E A D F, being the frustum of an inverted cone; and the capacity of it is of no consequence.

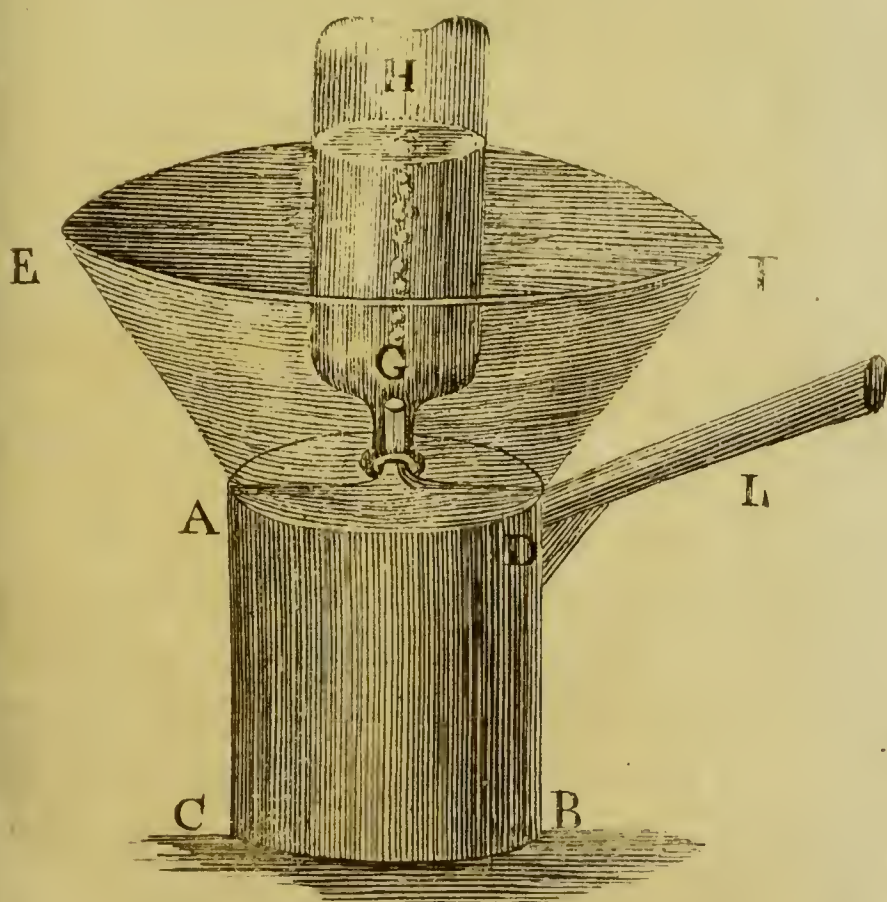
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\* See Experiments and Observations on the Horley-Green Spaw, p. 18.



When this vessel is used, the cylindrical part A C B D is accurately filled to the top of the tube G, with the mineral water to be examined; the shelving part E A D F is likewise filled to the height of about four inches, with the same or common water. A phial H G, filled with oil, alcohol, or even with common water heated to such a degree that it will not absorb the air, is inverted over the tube G K.

The vessel is then placed upon the fire, till it boils gently; all the air, or volatile matters contained in the half gallon of water, which fills the cylindrical part of the vessel, will be expelled by the heat, and rise up through the tube G K into the inverted phial, occupying the upper part of it, and displacing an equal quantity of the fluid, which will be forced into the shelving part. When no more aëriform fluid rises, the place in the phial, occupied by the air, may be marked with ink, a diamond, or a file. The phial is then to be



*W. Green sculpi*



be filled with distilled water to the mark, and accurately weighed, and by calculation, the quantity of air in cubic inches, will be very accurately determined; or, a graduated phial may be used, which will show, at first sight, the quantity of air contained in the water.

If one phial will not hold all the aëri-form fluid, it may be removed from the tube before it be quite filled with air, corked under water, and another phial applied.

### EXPERIMENT XI.

This vessel being filled with the Crescent water, and phials applied as above directed, I obtained 17,2 cubic inches, which in a gallon would be 34,4 cubic inches of permanent vapour, which being introduced into an inverted vessel, filled with lime water, was all, or very nearly all absorbed by agitation. The lime water assumed a turbid milky appearance,

pearance, and had evidently a sulphureous smell; whence I conclude, that the air contained in the Crescent water, consists of fixed and hepatic air, common air being never found either in sulphureous or chalybeate waters.\*

The next thing to be done, was to separate the fixed and hepatic airs from each other, which did not at first sight seem very easy, as both these airs are absorbed by water; I however attempted it upon the following principle.

When a sufficient quantity of lime water is mixed with water impregnated with fixed air, the air will be absorbed by the lime; but when lime-water is mixed with water saturated with hepatic air only, no decomposition will take place. I therefore took a quart of lime-water, and added to it a quantity of quick lime in powder, which was much more than sufficient to absorb the quantity of air contained in an equal

\* Bergman's Chemical Essays, Vol. I. p. 248, & 299.



equal quantity of the Crescent water, provided it was all fixed air : this I put into the cylindrical part of the vessel, and added to it a quart of the Crescent water, which exactly filled it : I then stopped the tube G with a cork, and having filled the shelving part to the height of about four inches, the mixture was suffered to stand about half an hour, in which time the fixed air must have been all absorbed from the water : I then applied an inverted phial, as above directed, and placed the apparatus on the fire ; when the air had ceased to rise into the inverted phial, the place occupied by it was measured, and found to contain 3,4 cubic inches. This air did scarce produce any decomposition when passed through lime-water, but impregnated it strongly with an hepatic or sulphureous smell. Since therefore a quart of this water contains 3,4 cubic inches, a gallon of it must contain 13,6 cubic inches of hepatic air, which subtracted from 34,4 cubic inches, the whole quantity of the air obtained by the  
first

first part of the experiment, leaves 20,8, for the quantity of fixed air. It appears then, that a wine gallon of this water contains 20,8 cubic inches of aerial acid, or fixed air, and 13,6 cubic inches of hepatic or sulphureous air.

### EXPERIMENT XII.

I poured a wine gallon of the Crescent water into a clean tin vessel, and placed it over a fire; air bubbles soon began to rise, the water grew turbid, and deposited a brownish sediment: it was suffered to boil for twenty minutes, before which time it had ceased to deposit any more sediment.

When the water was cold, I poured off the clear, till it came very near the bottom of the vessel; I then filtered the remainder, and having dried the filter, I found the weight of the powder left upon it to be  $5\frac{1}{10}$  grains.

EX-

## EXPERIMENT XIII.

That I might discover the nature of this powder, I exposed it for about a month to the rays of the sun, having frequently moistened it during that time : I then calcined it in a crucible, keeping it in a red heat for near an hour, and upon presenting a magnet to it, several particles were evidently attracted ; from this I was convinced that it contained iron. In order to separate the iron from the other substances which might be mixed with it, which are generally calcareous earth and magnesia, I put the powder into a phial, poured upon it a quantity of distilled vinegar, and let it stand two days, having frequently agitated it in the mean time. The distilled vinegar dissolves the magnesia and lime, but will not act upon iron which has been dephlogisticated by the rays of the sun, or by calcination.\* I then filtered the liquor, and having dried the powder on the filter, I found the

E weight

\* Bergman's Physical and Chemical Essays. Vol. I. p. 150.

weight of it to be exactly two grains ; the vinegar had consequently dissolved  $3\frac{1}{10}$  grains. This powder which remained on the filter, and which was not soluble in the distilled vinegar, was evidently iron : when calcined it was attracted by the magnet, and upon dissolving it in diluted vitriolic acid, the Prussian alkali precipitated it in the form of Prussian blue.

Hence it is evident that a gallon of the Crescent water contains two grains of iron, held in solution by fixed air.

#### EXPERIMENT XIV.

The acetous solution was next evaporated to dryness, and yielded a filamentous substance, resembling moss. This substance being exposed to a moist air for above a week, was not deliquescent, but permanent ; which was a proof of its being acetated lime, for acetated magnesia is deliquescent under the same circumstances.\* To be more certain of this, it was

\* Bergman's Essays, Vol. I. p. 161.



was dissolved in distilled water, a little of it was poured into a glass, and diluted vitriolic acid added to it, drop by drop. The mixture became in some measure turbid, and in about an hour, I found a substance at the bottom in the form of fine flakes, which had an insipid taste, and every appearance of selenite. Another part of the solution was poured into another glass, and lime-water mixed with it; but after it had stood more than an hour, no decomposition had taken place, which would have happened if any magnesia had been present; lime having a greater affinity for the vinegar than the magnesia has, and consequently would have separated that earth. To the remainder of this solution, a few drops of a solution of vegetable alkali were added: the mixture immediately became turbid, and deposited a copious sediment, which being collected by filtration, was put into a crucible, and kept in a red heat for more than an hour, and then dissolved in water. Some of the clear solution was poured into the  
bend



bend of a glass syphon, and upon making fixed air pass through it from my lungs, it immediately became turbid, and white like milk, which convinced me that it was calcareous earth; it was reduced to quick lime by calcination, in which state it was soluble in water, but was precipitated from it by fixed air.

From this it is evident that a gallon of the Crescent water contains  $3\frac{1}{10}$  grains of calcareous earth, held in solution by the ærial acid.

#### EXPERIMENT XV.

The gallon of water from which this precipitate (Exp. 12.) had been procured, was evaporated very slowly in an earthen vessel, to dryness, and I found at the bottom of the vessel, a quantity of whitish salt, the weight of which was 8 dwt. 1 gr.

#### EXPERIMENT XVI.

In order to see what acids this salt contained, I evaporated some more of the  
water,

water, and obtained a proportional quantity of salt. Upon part of this salt, I poured some concentrated vitriolic acid; a grey smoke was instantly produced, with a peculiar smell, which I knew to be that of the marine acid. I held a paper moistened with water over the salt, and the vapour instantly surrounded it, which was another proof of its being the vapour of the marine acid : \* the paper soon acquired an acid taste.

From this experiment it appears that that this salt contains the marine acid in its composition.

#### EXPERIMENT XVII.

A little of this salt was dissolved in water, and a few drops of salited terra ponderosa being mixed with it, the mixture soon became turbid, and a small quantity of a white precipitate fell to the bottom of the vessel.

From

\* Bergman's Essays, Vol. I. p. 167.

From this experiment it is evident that this salt contains some vitriolic acid in its composition.

To determine accurately the nature and quantity of each salt which this water might contain, I made the following experiments as directed by M. Bergman in his *Physical and Chemical Essays*,\* and M. Fourcroy in his *Elements of Chemistry*.†

#### EXPERIMENT XVIII.

(A) The salt which was collected from a gallon of the water, and which, as was observed before, weighed eight pennyweights and one grain, was put into a phial, and rectified spirit poured upon it to the height of about two inches; the phial was then well stopped and shaken, and after standing twenty hours, it was filtered.

(B) To

\* Vol. I. p. 159.

† Vol. II. p. 208.

(B) To the residuum I then added eight times its weight of cold distilled water ; the mixture was shaken, and after standing about twelve hours, it was filtered ; but nothing, or next to nothing was left on the filter.

I next proceeded to examine the solution obtained by the rectified spirit, which was of a brownish colour, and had a very bitter taste. As this solution generally consists of lime or magnesia salited or nitrated\*, to discover whether these salts were present, I made the following experiment.

#### EXPERIMENT XIX.

I took part of the salt obtained from the water in Exper. 16, and poured rectified spirit upon it, in the same manner as upon the salt procured from a gallon of the water (Exper. 18. A.) Part of this spiritous solution was evaporated to dryness, and upon pouring upon it some concentrated

\* Bergman's Essays, Vol. I. p. 164.

centrated vitriolic acid, and holding a wet paper over it, it was evident from the peculiar smell and grey smoke, which attached itself to the paper, that this salt contained the marine acid in its composition. Nitrated silver, upon being mixed with a solution of this salt in water, confirmed this, by the turbid appearance which it occasioned, and the precipitation which followed.

Into part of the remainder of this solution, I dropped some falited terra ponderosa; but no change was produced which indicated the presence of the vitriolic acid.

To determine the quantity of this salt, I evaporated the first spirituous solution (Exper. 18. A.) to dryness; and found 1 dwt. 21 gr. of a brownish salt which had a very pungent, bitter taste, and which, on being exposed to the air a very little time, became deliquescent.

The



The next thing to be done, was to discover the base of this salt, for which purpose I made the following experiments.

### EXPERIMENT XX.

A quantity of this salt was dissolved in water, and an equal quantity of lime water was mixed with it: a decomposition soon took place, and a precipitate in fine flakes like snow, fell to the bottom of the vessel. A little diluted vitriolic acid was mixed with tincture of turnsole, and this precipitate was added by degrees, agitating the mixture frequently, till by the colour I judged that the vitriolic acid was saturated with the earth. The solution was very transparent; it was evaporated almost to dryness, and on being suffered to stand two days, a few small crystals were observed at the bottom of the vessel, which from their figure and taste were certainly vitriolated magnesia or Epsom salt.

F

Hence

Hence it appears, from the preceding experiments, that the salt dissolved by the rectified spirit, was *salited magnesia*, and that a wine gallon of the Crescent water, contains 1 dwt. 21 gr. of this salt.

### EXPERIMENT XXI.

The solution made by cold water (Exper. 18. B.) was next examined; it was evaporated to dryness, and was found to weigh 6 dwt. 1 gr. which was three grains short of what it ought to have weighed, since the whole quantity of salt procured from a gallon of the water, weighed 8 dwt. 1 gr. (Exper. 15.) and the quantity dissolved by the alcohol being subtracted from it, leaves 6 dwt. 4 gr. Whether these three grains were lost in performing the experiments, or whether it might depend upon the salt having less of the water of crystallization, I am at a loss to determine. This salt was re-dissolved in water, and evaporated by a very gentle heat, till a drop of it being taken out of the vessel, and let fall upon cold  
glasses,

glafs, fhewed evident figns of cryftallization; it was then placed in an oven, near a fire for forty-eight hours, and in that time was converted into beautiful cryftals, which feemed all of marine falt; but this falt having been expofed to a damp air, for fome days, became in fome meafure moift: this circumftance, together with the experiment with the falited terra ponderofa, (Exper. 17.) fhewed that a vitriolic falt was mixed with it. I therefore diffolved the falt again in water, and added to it a folution of the *foffil* alkali, that the bafis of the marine falt might not be precipitated; the mixture after ftanding fome time, fhewed evident marks of a decomposition, and after it had ftood fix hours, a very fmall quantity of precipitate was found at the bottom of the veffel. This being carefully collected on a filter, was found to weigh  $1\frac{1}{2}$  grains. On pouring diluted marine acid on this earth, it was diffolved, and precipitated again by lime water, which was a proof of its being magnesia; confequently

quently the salt mixed with the marine salt, was vitriolated magnesia, or Epsom salt.

To determine the quantity of Epsom salt, from which this grain and half of magnesia was precipitated, Mr. Kirwan informs us, that 100 grains of crystallized Epsom salt contain 23,75 of acid, 19 of earth, and 57,25 of water: hence the quantity of crystallized Epsom salt from which this magnesia was produced must have been very nearly 8 grains. This subtracted from 6 dwt. 1 gr. leaves 5 dwt. 17 gr. for the quantity of muriatic or sea salt.

From the preceding experiments, a wine gallon of the Crescent water appears to contain

	dwt.	gr.
Of aërated iron	0	2
aërated lime	0	3 $\frac{1}{10}$
salited magnesia	1	21
muriatic or sea salt	5	17
vitriolated magnesia, or Epsom salt	0	8

Of



## Of aërial fluids

Aërial acid, or fixed air 20,8 cubic inches.

Hepatic, or sulphureous air 13,6 cubic inches.

Exclusive of a small quantity of aërial acid retained by the iron and lime in the heat of boiling water.

It may, at first sight, appear surprising that this water should contain magnesia united with the vitriolic and marine acids, and at the same time, calcareous earth combined with fixed air; for we might, perhaps, expect, that the calcareous earth, which has a greater affinity for those acids than magnesia has, would separate that earth, and combine with them, and leave the magnesia at liberty to combine with the fixed air. But such examples frequently occur in chemistry, and can only be explained by what the chemists call double elective attraction, whereby it happens that substances are often combined differently from the order of simple affinities; because the sums of the attractive forces



forces which hold them in combination, are greater than the sums of the forces which endeavour to separate them.

To illustrate this, let us suppose, that A is a stronger acid and B a weaker, also that C is an earth which has a greater attraction for those acids than D has. Suppose the attraction between A and C  $= x$  and the attraction between A and D which is less,  $= x - 1$ ; suppose that the attraction between B and C which is likewise less than the attraction between A and C be also  $= x - 1$  but the attraction between B and D being the least of all, we may suppose  $= x - 3$ . Suppose next that A is combined with D and C with B, yet there will be no separation, though C has a greater attraction for A than it has for B. for the forces which keep the compounds together will be equal to the sums of the attractions of A for D and C for B,  $= 2x - 2$ , but the forces which tend to separate them will be  $2x - 3$ , which being less than the forces by which they are kept together, will produce no effect.

Having

Having finished the account of the analysis of the Crescent water, I shall proceed to make a few remarks on the diseases in which it has been found useful, and also on the method of using it with the greatest prospect of success.

Although from the knowledge of the contents of this water, we might from analogy, deduce its virtues in particular diseases, yet this method of reasoning *a priori*, is by no means so certain and satisfactory as that which depends on facts and experience. For this reason, I should have wished to have confined myself entirely to the result of experience, but our knowledge of the medicinal virtues of this water is yet in its infancy. It is true, we are in possession of several cases, in which it has been successful, and many more have probably escaped the observation of medical practitioners; but still it may be presumed that there have not been sufficient opportunities of ascertaining all the virtues of a water so lately discovered.

When

When we take a view of the preceding analysis, we are struck with the variety of substances contained in this water. It contains within itself all the principles which are to be found in any of the other waters at this place. It resembles the waters at High-Harrogate, as containing iron held in solution by fixed air ; and the sulphur water at Low-Harrogate, being impregnated with the same salt, and the same aëriform fluid, the heaptic gas. It likewise contains a salt, which, according to the analysis of different authors, is not to be found in any other water at Harrogate, viz. the vitriolated magnesia, or Epsom salt.

I shall first consider the medicinal virtues which each substance contained in this water, possesses in its separate state; though I fear that such an account, however circumstantial it may be, may not convey the proper information concerning the genuine effects of the water, when drank at the pump, since the medicinal  
effects

effects of a compound are often different from what might be expected from the known qualities of the ingredients. We must therefore rely upon experiments for a proper knowledge of the virtues of this water as an aggregate, rather than upon reasoning on its constituent parts ; though it is proper, carefully to investigate both.

I shall first begin with iron:

This metal has long been celebrated, as a tonic, and for that purpose has been exhibited under various forms ; and it is certainly one of the most useful remedies that can be employed in diseases proceeding from debility or a laxity of the fibres. The great Boerhaave observes that no medicine either animal or vegetable ; no diet, no regimen can produce the effects, which are, in these cases, accomplished by iron. It is often used in its metallic state, and frequently in the form of a calx ; in both of which forms, when exhibited in considerable quantity, it produces very  
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great effects as a tonic; but the most powerful and efficacious form in which this remedy is ever exhibited, is in a saline state, or combined with an acid: yet none of the saline preparations agree so universally with patients, as that, in which this metal frequently exists in mineral waters, viz. in the form of aërated iron. This constitutes an active saline chalybeate, which warms and invigorates the system, promotes appetite and digestion, and at the same time that it acts as a diuretic or diaphoretic, prevents the languor or debility which is often the consequence of these evacuations.

Though the quantity of iron contained in the Crescent water, is but small, yet we generally find that in cases of chronic weakness, chalybeates in very small doses, continued for a considerable length of time, produce effects which could not be obtained from a more liberal use of that metal. In confirmation of this observation, I shall transcribe the following remarks



marks from Dr. Cullen's Lectures on the Materia Medica. " In all cases of laxity and debility, and in obstructions and slowness proceeding from these causes, iron is employed, though other simple astringents might also answer the effect. Here we ought to beware of too sudden an astringent, which might be attended with bad consequences; and therefore, in exhibiting it in these cases, we should give it in small doses, and trust to length of time for a cure; and by this means we shall avoid those inconveniences of which physicians often complain in their preparations of iron. Mineral waters often produce cures which we in vain attempt to perform by the combinations in our shops, even although these waters contain nothing but iron. This is manifestly owing to the weakness of the dose; in proof of which we find that the strongly impregnated waters seldom answer so well as those weak ones we commonly reject." The Crescent water indeed, contains as much iron as can possibly be suspended by the  
quantity

quantity of fixed air with which it is impregnated ; for, according to M. Bergman, a hundred cubic inches of this air take up only about four grains of iron. \*

Having given a short account of the effects of iron, I shall next take notice of another active principle with which this water is impregnated. I mean the fixed air ; the properties of which have been but little known till lately, though this fluid is almost every where present.

The quantity of fixed air contained in the Crescent water, is very considerable, and it is this fluid which produces the sparkling appearance when poured out of one glass into another. It is that portion only which is loosely attached, and which can be separated by a gentle heat, which can contribute any active medicinal power to the water. The remainder, which adheres so closely to the earthy basis as not to be separated in the heat of boiling water,

\* Bergman's Essays, Vol. I. p. 220.

ter, nor perhaps by any other means than calcination, or the affusion of a stronger acid, is probably too inert to exert any considerable medicinal virtues.

When pure water is impregnated with fixed air, it acquires an exhilarating, and even inebriating quality. It is to this principle that mineral waters are indebted for their agreeable smartness and poignancy. It contributes much to the activity of the other ingredients, and (as Dr. Fothergill observes,) enables them to pervade the remotest recesses of the human frame and subdue some of the most obstinate diseases. To what other principle in their composition, says he, can we rationally attribute these surprizing effects? not surely to the water alone, which is incapable of producing them; much less to the mere solid contents, which either jointly or separately considered, are too inactive to exert such extraordinary powers.

Fixed

Fixed air is likewise a very powerful antiseptic, and Dr. Macbride has shown that without the extrication of this air, putrefaction cannot take place, and that by immersing putrid or putrescent substances in this air, they are rendered sweet. Fixed air, when taken into the body, has always, and very justly, been esteemed as a most powerful antiseptic; and with this view it has been exhibited with success in the scurvy, and in fevers of the putrid type; and when united with water, and other liquors, it exerts considerable powers as a corroborant or tonic remedy.

The hepatic air which this water contains, will impart to it the same virtues possessed by the sulphur waters, in proportion to the degree of impregnation; though in the cure of cutaneous complaints, it must certainly give place to the sulphur wells, which are more powerfully impregnated with this air.

Though



Though the salts contained in this water, are too small in quantity to render it proper to be used as a purgative, except when drank in very large doses, yet it operates as a gentle laxative; and I think it highly probable that the saline chalybeate principle is also assisted in its operation by the purging salts contained in this water, which will not only prevent the bad effects which sometimes attend the use of chalybeates as tonics, but will act as a grateful stimulus to the stomach and intestines; will be absorbed by the lacteals, and being carried by the circulation through the various glands, it will, by gratefully stimulating them, promote the several secretions, and particularly by its operation on the kidneys and glands of the skin, will promote the diuretic and diaphoretic effects of this water.

I shall next say a few words concerning the sensible effects produced by the Crescent water, when drank fresh from the pump.

Soon

Soon after a person has drank a glass of this water containing about half a pint, he feels a pleasant sensation about the stomach, with a kind of agreeable warmth over the whole body ; his spirits are exhilarated, and he finds himself more disposed, and better qualified to enter upon study, business, or pleasure. If the water is taken in the forenoon, betwixt breakfast and dinner, it generally creates a sharp appetite, and the person eats his dinner with greater pleasure than when he does not drink this water. When it is drank in a morning, and pretty brisk exercise used, it acts very powerfully as a diuretic ; though when the weather is warm, or the body warmly cloathed, it is more apt to increase perspiration.

From the above mentioned effects, which I have myself frequently experienced, and learned from others who have drank it under my direction, it appears that this water acts as a tonic, diuretic, and often as a diaphoretic : it operates

rates as a very gentle stimulus, and constitutes a mild, but active medical compound, well calculated to strengthen the stomach, and promote digestion; to cleanse the first passages, to purify the chyle and lymph, and clear the whole glandular system. By uniting with the bile, and other alimentary fluids, in its passage through the intestines, it stimulates the glands dispersed upon the surface of the intestinal canal, to pour out their contents; by which it in some measure deterges the canals of the liver, spleen, pancreas, and other viscera, and removes obstructions in them. It likewise stimulates the lacteal or absorbent vessels, which are distributed upon the coats of the intestines, and by innumerable mouths, take up the nutritious part of our food, and convey it to the blood, and makes them perform their functions more vigorously.

The diseases in which this water has been found useful, or in which we may

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expect



expect it to be beneficial, are almost all of the *chronic* kind, by which is meant those diseases which have been of long standing, and in which there is not *immediate* imminent danger: by this term they are distinguished from inflammations, fevers, &c. in which the sick are generally confined to their beds, and the disease terminates in the course of a few days, either favourably or unfavourably; these last are called *acute* diseases: and in these we cannot expect much benefit from mineral waters, even if the patients could have recourse to them.

The diseases in which mineral waters are found beneficial, require their use for a considerable time, and we have frequent instances of patients who might have been cured by them, who have gone away because they found no benefit from drinking them a few days: but patients ought not to be dissatisfied if they receive no great benefit from the water in the space of a week or a fortnight; for, where diseases  
have



have continued a long time, it would be folly to expect that they could be easily and speedily removed.

The diseases in which we may expect to find the Crescent water useful, may with propriety be divided into the three following heads.\*

1st. Those in which the stomach is principally affected.

2d. Those of the intestines, and other abdominal viscera.

3d. Those of the lymphatic system.

1. Those diseases in which the stomach is principally affected, are sickness, vomiting, heart-burn, acid eructations, spasmodic pains in the stomach, indigestion, and loss of appetite. In cases of gout, particularly in that species called the *atonic*, where  
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\* This division was suggested by the perusal of Dr. Fothergill's Inquiry concerning the Cheltenham Water, from which, I received much information and entertainment.

the system has been weakened by frequent and severe attacks of that disorder, we may expect benefit from the Crescent water, when drank in a proper manner. I have placed the atonic gout among those diseases in which the stomach is principally affected; for though in this disease, the whole habit is generally very much debilitated, yet the stomach is commonly more disordered than any other organ.

2. The diseases of the intestines and other abdominal viscera, in which the Crescent water may be used with advantage, are colic, or spasmodic pains in the bowels, flatulency, hypochondriac affections and habitual costiveness which generally accompanies that disorder; jaundice, whether from a spasmodic affection of the biliary ducts, or from gall stones; stone and gravel; piles.

3. The diseases of the lymphatic system, in which this water may be expected to be useful, are schirrus affections of different

rent glands; scrophula; rickets; scald head; leprosy; venereal complaints of long standing, especially those accompanied with cutaneous eruptions.

Several of the above mentioned diseases have yielded to the use of the Crescent water, but many of them are of so obstinate a nature, that much depends upon beginning with the water early, and persevering for a sufficient length of time.



# DIRECTIONS

## CONCERNING THE USE OF THE CRESCENT WATER.

As in many complaints in which the Crescent water is recommended, particularly those of the nervous kind, its efficacy is very much promoted by various concomitant circumstances, such as chearful and agreeable company, and exercise in the open air ; this points out the summer as the most proper time for drinking it, because these concomitants cannot be enjoyed in winter, in an equal degree : it may however, in cases of necessity, be drank at any season, though perhaps not with equal advantage. The best times for drinking it, are, before breakfast, betwixt breakfast and dinner, and in the evening ; the usual dose is from half a pint to a pint, or from one to two glasses ; though, at first, one glass will sometimes be found too large a dose, and produce sickness, and a sense of weight and oppression in the stomach ; for which reason,  
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it will be always prudent to begin with half a glass; and if that dose is found to agree, it may be gradually increased to one or two glasses. As part of the bore of the pump always contains a little water, which has remained since the last time of pumping, and consequently will have lost part of its fixed air, and deposited some of its iron; it will be proper to pump once or twice into the cistern, before you receive it into the glass.

It is common to direct the sulphur water to be used in the morning before breakfast, and that of the Crescent before dinner; I am, however, unwilling to subscribe to this mode, till I am perfectly convinced that the chalybeate principle of the Crescent is not injured by the sulphur water. In the former part of this treatise, I mentioned an experiment which may be made by any person: When the Crescent water is mixed with that from the sulphur wells, the mixture becomes turbid, and of a blackish hue; and if it  
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is suffered to stand for some time, a black precipitate falls to the bottom of the vessel, and the superincumbent liquor does not show any marks of its containing iron, on mixing it with tincture of galls or Prussian alkali. From this, it is obvious, that the iron is precipitated from the Crescent by the sulphur water. The virtues of this chalybeate depend upon its saline state, or the iron being dissolved by fixed air; but this state is destroyed by the sulphur water, and the quantity of iron which is precipitated in the form of a calx, is too small to produce any sensible effect. Whenever therefore, it is necessary to use the sulphur water, I would advise the omission of the Crescent water for that day. Where the Crescent water is not sufficient to prevent costiveness, one or two of Rufus's pills, or a little *lenitive electuary* may be taken at bedtime; or a small quantity of Harrogate, or Epsom salt may be dissolved in a glass of the water.

These

These observations are likewise applicable, and perhaps in a greater degree to the use of the chalybeates at High-Harrogate along with the sulphur water.

### DIET AND REGIMEN.

A circumstance that surprized me, when I came first to Harrogate, was the use of tea, at the same time that patients were drinking the chalybeate waters. Many, for instance, breakfast on tea, and in an hour or two afterwards, drink the Crescent water, or the chalybeates at High Harrogate. None of the faculty, to the best of my knowledge, have noticed the impropriety of this part of the diet of persons who are drinking chalybeate waters ; but a simple experiment must convince every one of it. If a little of the infusion of tea is mixed with the Crescent water, or any other chalybeate, the mixture assumes a purple colour, inclining to black, nearly as much as when tincture of galls is mixed with these waters. When the mixture is suffered to stand for some time, the iron

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is all precipitated in the form of a black powder, and neither tincture of galls, nor the Prussian alkali, produce any effects upon the superincumbent liquor. The same will undoubtedly take place in the stomach and first passages, if a chalybeate water is drank within an hour or two after tea. Since therefore, the small quantity of iron which is contained by the aërated chalybeate waters, owes its efficacy to its saline state, or union with, and saturation by the aërial acid; tea by precipitating it from this solvent, must destroy its effects.

From hence it must be obvious, that independent of the impropriety of tea, to those who labour under nervous complaints, and disorders of the stomach, which almost every one will be ready to allow, it must be highly improper during the use of chalybeate waters. I would therefore advise those who are drinking the Crescent water, to breakfast either on chocolate or cocoa, instead of tea. Those  
with



with whom milk is found to agree, will find no bad effects from the use of it along with this water.

With regard to dinner, I would, in general, advise those who drink this water, not to indulge too freely the keen appetite which it commonly promotes. We are all acquainted with a maxim, which, if it was practised as universally as it is acknowledged, would be productive of the happiest effects, viz. always to rise from table with some remains of appetite. By this means the stomach would not be cloyed, but would easily digest its contents, which it cannot do when it is overloaded. Any kind of fresh animal food that will agree with the patient may be eaten with moderation; but the tables at Harrogate are frequently crowded with so many luxuries, that it is often difficult to resist the temptation of tasting several dishes.

The best rule is that given us by Dr. Armstrong.

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When dinner comes, amid the various feast,  
That crowns your genial board, where every guest,  
Or grave, or gay, is happy and at home,  
And none e'er sighed for the mind's elbow room ;  
I warn you still to make your chief repast  
On one plain dish, and trifle with the rest.

A DAY, *an Epistle from Germany.*

Most of the diseases in which this water is of use, require a generous temperance, rather than a severe abstinence : a glass of generous wine may be drank after dinner ; but the patient should be very cautious not to indulge himself too much, nor take this advise as a licence to gratify a strong and depraved habit, or inclination. The spirits are never thus artificially raised, but when the stimulant effect of wine is over, they sink proportionally, and the next day the hypochondriac finds his anxious cares and the gloomy state of his mind redoubled.

I would by no means object to the use of summer fruits, either before or after dinner, provided they are perfectly ripe, and eaten sparingly.

If

If suppers are to be allowed, they should be taken early, and of the lightest kind, and vegetable food is preferable to animal. Nothing, in my opinion, contributes so much to the production of the various disorders of the stomach, as full suppers. The evening is by no means the proper time to take much nourishment ; for, as I have observed in another treatise, the powers of the system, and particularly of the stomach, are almost exhausted, and the food will be but half digested. Besides the addition of fresh chyle to the blood, together with the stimulus of food acting on the stomach, always prevents sleep, or renders it disturbed. And instead of having our worn out spirits recruited, by what is very emphatically called by Shakespeare the “ chief nourisher in life’s feast,” and rising in the morning fresh and vigorous, we become heavy and stupid, and find the whole nervous system relaxed.

EX-

## EXERCISE.

Nothing contributes so much to the preservation or restoration of health, as exercise in the open air. The most proper time for taking it is in the morning, before breakfast, or between breakfast and dinner, the body being then more alert, and the mind more chearful, and better disposed to enjoy the pleasures of a ride or walk. Though the soil at Harrogate, is as yet in a barren state, owing to its having been lately inclosed, yet it is in the center of rural beauties. There are many delightful scenes at no great distance, which frequently induce the company at Harrogate to visit them. But these are so fully treated of by Mr. Hargrove, in his History of Knaresbrough and Harrogate, as to supersede the mention even of their names, in this essay.

A walk or ride before dinner will greatly contribute to the salutary effects of the water; the patient generally returns with



a keen appetite, and the stomach is enabled to perform its functions properly. Exercise after a full meal, generally disturbs digestion, and causes painful sensations in the stomach and bowels, with sickness and heart-burn, &c. It is scarcely necessary to observe that the exercise ought always at first to be moderate, and never so great as to occasion much fatigue.

In order that those who are drinking this water, may receive all possible benefit from it, it is not only necessary that every kind of excess be avoided, but the mind ought to be kept in a state of tranquility, or agreeably amused. All anxious cares, thoughts of domestic affairs, and concern about business, must for a while be dismissed, and every source of grief or melancholy, as much as possible prevented. To this the sociability of the company at Harrogate, and its various amusements will very much contribute.

The

The Crescent water has sometimes been used as a warm bath ; but I cannot see what superior efficacy it can have over the sulphur water in this respect ; the chalybeate principle is deposited on its being heated, and it contains less salt and sulphureous gas than the other. Besides, in many of the diseases in which this water is useful, the warm bath is improper ; as it generally relaxes the patient, already too much debilitated. The effects of this water may however be very much promoted by the cold bath, where there is nothing to forbid its use. I shall here repeat the observations which I made on the use of this remedy in another treatise, and which I think highly necessary to be attended to. In all cases where the cold bath is used as a remedy, the patient should plunge into it, and come out immediately ; his body ought then to be [exceedingly well rubbed with woollen or linen cloths, and he should cloathe himself as soon as possible.

I have been favoured with a number of cases in which the Crescent water has been found useful in relieving several obstinate diseases which had resisted the use of other remedies. But I do not think it necessary to insert them here, especially as the greatest part of them have already been published; they were drawn up by an eminent physician, and inserted in the Leeds Intelligencer, and have since been separately printed. The only cases I shall notice are the following, which were communicated to me by my friend Mr. Jaques, a very intelligent surgeon and apothecary, who attends Harrogate, and has had frequent opportunities of observing the good effects of the Crescent water.

#### CASE I.

A married lady between fifty and sixty years of age, of a nervous habit, came to Harrogate in July, 1790. Her complaints were pain of the stomach, nausea, and other symptoms of indigestion; several

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of her family had been afflicted with the gout, but she never had the least symptom of it. She was advised to drink a glass of the Crescent water first thing in the morning, another about an hour after, the same dose at eleven o'clock A. M. and again at four o'clock P. M. Before she had continued its use in this manner for a week, the pain of the stomach and symptoms of indigestion left her, and she was attacked with a pain and swelling of her hand, which continued while she remained at Harrogate, which was about a month; her general health being much better.

## CASE II.

A. B. of K. between fifty and sixty years of age, for a number of years had at times been afflicted with lowness of spirits, pain and foreness of the stomach, want of appetite, and restless nights. A variety of medicines had been used without effect, particularly the bark, aromatics, bitters,



bitters, and other nervous medicines, such as the volatile alkali, fœtid gums, &c.

In the month of April she was advised to drink the Crescent water to the extent of three glasses in the day ; viz. one before breakfast, another at eleven o'clock, and another at three o'clock. She found relief in about a week, and after drinking the water a fortnight, thought herself much better. If she omitted the water, even for a day, the complaints returned, but on having recourse to it again, she always found immediate relief. After using it about three weeks she got quite well, and has since enjoyed a good state of health.

### CASE III.

Mr. R. aged sixty-five. In the month of April 1790, came to Harrogate. His skin was full of hard tumors, which discharged an ichorous kind of matter, and his blood oozed out at several places ; in  
short

short he seemed to be in a state of universal putrefaction. He was advised to drink the Crescent water, which he did very constantly, only drinking a little of the sulphur water now and then to prevent costiveness. In about two months he was astonishingly better; the ulcers healed, his strength, (which had been greatly impaired,) returned, and he became, as it were, another man.

#### CASE IV.

Mrs. C. aged thirty five. Had for a considerable time complained of general weakness and want of appetite, and was very much emaciated. She had tried a variety of medicines, but without any permanent relief. In the month of March, 1790, she was advised to drink about half a glass of the Crescent water, three or four times a day, and to increase it to a whole glass. She found relief from it in a few days, and has since continued in a pretty good state of health.

Mr.

Mr. Jaques adds, that he has found this water of the greatest use, where the stomach was weak and relaxed, and the appetite bad, and also in bilious complaints ; in all such cases, he recommends it with the greatest confidence, and is seldom disappointed.

THE END.

